Analysis of Indications for Intensive Care Unit Admission*

Clinical Efficacy Assessment Project: American College of Physicians

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Objective: To formulate recommendations for the development of intensive care unit (ICU) admission policies. Design: Literature review of published reports over the period 1966 to 1991 pertaining to admission criteria for intensive care or coronary care units (CCUs). Patients: Studies identifying patients least likely to benefit from ICU or CCU admission were analyzed. Patient populations of interest included adults (≥18 years of age) with medical conditions possibly requiring intensive care; trauma patients were excluded. Measurements and main results: Of 970 articles identified as being pertinent to intensive care, only two case-control studies used the direct method of measuring the effect of ICU intervention on mortality. No studies were found that compared outcomes of low-risk patients treated in a CCU vs those treated in alternative hospital locations, and none identified patients with a very high probability of a bad outcome. Conclusions: The use of decision-making models for ICU and CCU admissions must be tested in prospective, randomized clinical trials. Critical care units and ICUs should be studied separately. Existing studies of early discharge from CCUs need to be summarized and evaluated. The triaging of ICU patients to alternative hospital locations needs to be evaluated, as do existing predictive models for early triage decision-making. (Chest 1993; 104:1806-11)

The concept of grouping patients according to the severity of their illness is more than 100 years old. However, it was not well accepted until burn units and trauma centers were established in the 1940s and 1950s. The stimulus for this change was primarily administrative; patient care could be made more efficient because equipment and specially trained personnel could be grouped and located appropriately. Also during this time period, the rapid development of new procedures and equipment made the need for grouping critically ill medical patients more apparent. Good examples of such innovations are central venous pressure monitoring and mechanical ventilation. These developments led to the growth of intensive care units (ICUs) in the early 1960s. Patients were often critically ill and required aggressive management techniques and specially trained personnel; mortality rates were higher than those observed among other hospital patients. Initially, ICUs were developed for coronary care; later, their role expanded to include all critically ill patients. The ICU concept was adopted by most large, tertiary referral centers, as well as by some community hospitals in the 1960s.

This occurred despite a lack of objective information to document the costs and benefits of the ICU in terms of education and research, as well as in terms of patient care. Indeed, at least some of the pioneers who developed the ICU believed that "The cost of coronary care units should not prevent their development" and that admission policies should be liberal. Of course, these statements were made under different financial constraints than exist today.

During the first decade and a half of ICU growth, no randomized trials and few observational studies had been performed to compare the costs and benefits of conventional care with those of ICU care. Several observational investigations that evaluated patient outcomes were conducted, but these were limited primarily to patients with acute myocardial infarction, respiratory failure, or stroke. Each of these observational studies had methodologic weaknesses, including inadequate control groups, failure to control for baseline prognosis (or severity of illness), lack of clear diagnostic criteria, and failure to use appropriate statistical methods for data analysis. In 1973, two articles were published that documented the fact that, for some groups of patients, ICU care cost more but provided no concomitant improvement in morbidity or mortality.

Griner,* pointed out the need to investigate the costs and benefits of the ICU aggressively and to identify patient "conditions" that were most likely to benefit from ICU care. He concurred with Bloom and Peterson* in suggesting that ICU care was more expensive for certain patient groupings, while morbidity and mortality were not improved, relative to

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FN = false negative; FP = false positive; NPV = negative predictive value; PaS = preadmission screening; PPV = positive predictive value; TN = true negative; TP = true positive.
conventional care. Griner identified two conditions for which ICU care was of no greater benefit than was conventional care: patients who have relatively low risk of death and patients who have high risk of death or who are in a persistent vegetative state. Unfortunately, these publications did not immediately stimulate research on the costs and benefits of the ICU.

In 1980, Thibault et al reported 2,693 consecutive admissions to an ICU, of which 77 percent were admitted for noninvasive monitoring. Among this group, only 10 percent of patients subsequently required one or more major diagnostic or therapeutic procedures. More recently, Knaus et al have replicated the Thibault et al studies in a medical-surgical ICU population and demonstrated that a severity of illness index can be used across a broader spectrum of diagnoses to identify low-risk patients suitable for expedited transfer.

In 1983, a National Institutes of Health consensus conference was convened to study ICU operation, including whether ICUs decreased morbidity or mortality and, if so, which patients were most likely to benefit from intensive care. Based on empirical evidence, the conference concluded that ICUs decreased morbidity and mortality for a select group of patients, but that the evidence was equivocal for the majority of patients. Furthermore, it was suggested that the “weight of clinical opinion is that ICU care improved survival” and that, for some patients, “the risk of iatrogenic illnesses associated with ICU care may outweigh any potential benefit.” Indeed, a study by Rubins and Moskowitz found that complications occurred in 42 (14 percent) of 295 consecutively admitted ICU patients, 22 (8 percent) of which were serious.

At present, admission to an ICU is influenced by a number of factors, including the severity of illness, the degree of suspicion for a particular diagnosis, the presence of an ICU medical director (or some other “gatekeeping” mechanism), the treatment preferences of the patient, the type and location of the hospital, and the ICU bed census. For ICUs that receive patients with a broad spectrum of potential diagnoses, the primary issue is risk of death; that is, identifying which patients are either not sick enough for admission or are too sick to benefit from intensive care. Preadmission screening (PaS) can result in the admission of such patients to more appropriate, and usually less costly, management sites. The ICU can then be reserved for those patients whose risk of death might be expected to decrease by virtue of the care they receive in the ICU.

The precise prognostic stratification threshold levels for routing patients to the most appropriate management location are unknown. This article is concerned with reviewing previous work to determine whether upper and lower boundaries for ICU admission criteria determine which patients are likely to benefit from being routed to an intensive care area. It is important that prognostic stratification be performed periodically (at least every 24 h), because prognoses change over time.

**Goals and Objectives**

The first step in developing ICU admission criteria should be to develop a reliable mechanism that is capable of distinguishing patients who are likely to benefit from ICU care from those who are unlikely to benefit. In our opinion, patient health is the most important criterion for determining access to intensive care; other issues, such as economic or legal considerations, are important but secondary. We therefore believe that the initial questions to be answered in the development of ICU admission criteria are as follows: (1) Do patient outcomes (survival as well as quality of life and other measures of health status) differ among low-risk patients treated in an ICU vs those denied access and treated in an alternative location (eg, an intermediate care area or the hospital ward)? (2) If no differences are observed among the least ill, low-risk patients, at what point on the continuum of the admission severity of illness scale do differences appear? (3) Can patients with a 100 percent chance of bad outcome (death or persistent vegetative state) be identified before admission and treated in an alternative location, such as the hospital ward or a special unit for the care of terminally ill patients?

Other determinants of ICU admission, such as the ICU bed census, the availability of nursing resources, economic considerations, ethical or moral considerations, physician’s treatment preferences, and the capability of an ICU to provide a minimum level of care are not considered in this document. Our conclusions are based on the assumptions that ICU beds are available, that there is no nursing shortage, that the cost of care is not an issue, that there are no ethical or moral issues influencing admission, and that a minimum level of intensive care, as previously defined at the 1983 NIH Consensus Conference on Critical Care Medicine, can be provided. These issues are important, but beyond the scope of this article.

The patient population of interest in this study consists of adults with acute medical problems.

**Methodologic Considerations**

One important issue when considering the development of models capable of identifying patients who are likely to benefit from intensive care is whether the model is disease specific or whether it can be applied across a broad spectrum of diagnoses. Another issue is that of selecting the independent (predictor)
variables and the patient outcome variables, as well as determining the timing of data collection. Some of these issues are being considered in critically ill adults in the multicenter Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatments (SUPPORT) now underway.33

Because it would now be considered unethical to randomize patients to intensive care, studies aimed at identifying the patients most likely to benefit from this level of care have usually taken an indirect approach (ie, investigators have taken admission policies as they exist and identified which patients are least likely to benefit).18 Implicitly, the remaining patients are those most likely to benefit. This indirect method of identifying patients unlikely to benefit from intensive care carries with it important limitations and assumptions. First, the standard method of evaluating any health intervention, including the approach recommended by the Agency for Health Care Policy and Research for developing clinical practice guidelines, has been the direct approach, in which the intervention is evaluated prospectively using a randomized design.34 Obviously, the indirect approach increases the potential for incorporating bias because it is observational. One approach to this problem has been to use a case-control design with the same inclusion and exclusion criteria that would be applied to a randomized trial.35,36 Although this approach is promising, there has been little experience with its use, and its validity is unknown.

Patient outcomes define a continuum, ranging from a health status that has improved relative to preadmission health status, to a health status that is worse than it was before admission (including a fatal outcome). In most cases, the health status of a patient does not improve relative to baseline after admission to an ICU, so we are primarily concerned about the degree to which health status is worsened, if at all. It is also important to know the time at which postadmission health status is measured. The critical time periods are the time of ICU discharge, the time of hospital discharge, and various time periods thereafter (6 months, 1 year, 2 years, etc). It is important to note that most ICU studies evaluate patient outcomes as a binary variable (lived or died) at the time of ICU or hospital discharge.

METHODS

Retrieval of Scientific Evidence

We reviewed journal articles, monographs, and textbook chapters to obtain data for analysis; unpublished information was not used. Journal articles were identified using MEDLINE, via the Data Star service. The search strategy used broad search terms so that the search sensitivity was high; once retrieved, the relevant articles were selected for analysis using predetermined criteria for inclusion and exclusion. The search encompassed writings in the English language for the years 1966 through December 1991. The following search terms were used: (1) "intensive care units" (MESH term exploded, excluding recovery-room or burn-units); (2) "critical care" (MESH term exploded); (3) title or descriptor fields containing the terms "utilization," "rationing," "outcome," "costs," or "APACHE" (truncation was used to identify variations of the words); and (4) MESH terms or descriptor fields containing "severity of illness index," "length of stay," "survival analysis," or "decision-making."

Our search combined elements from numbers 1 or 2 with those from numbers 3 or 4 (ie, "intensive care units" or "critical care" and "utilization . . . . . APACHE" or "severity of . . . making."). To reduce the number of irrelevant articles, we deleted descriptors related to drug administration, adverse effects, therapeutic use, and surgery (exploded surgery-operative). Other steps to limit the number of citations were not used, however, because of the nonspecific indexing used for some articles and because of the need to maintain a high sensitivity. Articles pertaining to burn units, pediatric or neonatal units, or mobile ICUs were identified and deleted by one of us (N.E.M.) during manual review.

To be eligible for data analysis, retrieved articles, monographs, and textbook chapters needed to do the following: (1) report actual data from studies of ICU admission; review articles, editorials, and single case-reports were excluded; (2) identify patients least likely to benefit prior to ICU admission; studies reporting data used for early transfer or collected after admission were excluded; and (3) report patient populations of interest (ie, adults 18 years old or older with medical conditions possibly requiring intensive care). Populations younger than 18 years of age or persons admitted to surgical or trauma intensive care centers were excluded; studies of populations undergoing transportation with a mobile ICU unrelated to ICU admission were also excluded.

Diagnostic performance was evaluated using sensitivity, specificity, accuracy, positive predictive value (PPV), and negative predictive value (NPV). These values were either obtained directly from the article or, where data were provided, calculated using the number of true positives (TP), true negatives (TN), false positives (FP), and false negatives (FN). The following formulas were used:

\[
\text{Sensitivity} = \frac{TP}{TP + FN} \\
\text{Specificity} = \frac{TN}{TN + FP} \\
\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN} \\
\text{PPV} = \frac{TP}{TP + FP} \\
\text{NPV} = \frac{TN}{TN + FN} \\
\]

Meta-analysis was not performed because the studies identified were not suitable.

RESULTS/DISCUSSION

Our literature search identified 970 articles broadly related to intensive care; 489 articles were subsequently eliminated because they did not pertain to the population of interest (ie, they pertained to neonatal, pediatric, burn, postoperative or trauma patients, CCU admissions, or the operation of a mobile ICU for transportation purposes). The entire bibliography was then evaluated for original research data that related directly to PaS of patients before ICU admission.

Identification of Patients Unlikely to Benefit From an ICU

Two case-control studies used the direct method of measuring the effect of ICU intervention on mortality.35,36 Deaths were compared with a matched (age and sex) sample of survivors, with respect to management location (ICU or floor admission); differences in the severity of illness between the exposure groups

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Indications for ICU Admission (Bone et al)

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were controlled for by stratified analysis. The admitting residents rated severity of illness and stability at the time of ICU admission. Management in the ICU had a relatively strong positive effect on survival for unstable, moderately ill patients (odds ratio 15.6 and 13.3, with 95 percent confidence intervals of 0.7 to 331 and 2.9 to 27.7, respectively); its effect on other subgroups appeared to be minimal. Both studies had the problem of low statistical power in the subgroup analyses, as was evidenced by the large confidence intervals. However, the results were not surprising. On the continuum of severity of illness, patients at the low end (stable, not ill to moderately ill) are probably not sick enough to demonstrate a benefit from intensive care and patients at the high end (unstable, severely ill) are too sick to benefit.

From among studies using the indirect approach to identifying patients unlikely to benefit from intensive care, those using a generic (non-disease specific) approach were excluded except one by Franklin et al. These authors reported an observational study in which APACHE II scores were calculated on 2,419 medical admissions of whom 218 (9.0 percent) were admitted to a medical ICU. APACHE scores were calculated using data available prior to PaS. There was considerable overlap between the APACHE scores of patients admitted to the ward and those admitted to the ICU. For example, APACHE II scores below 6 were observed for some ICU patients and scores higher than 30 were observed for some ward patients. Diagnosis-adjusted scores demonstrated a more favorable receiver operating characteristic curve than the APACHE II scores. These data suggest that disease-specific models may perform better than non-disease-specific models for admission triage decisions. Studies that were excluded are described below.

The studies by Knaus et al. that used the APACHE system were excluded because the data were collected after admission and were used for early transfer decision-making. Also, the patient population included postoperative and other types of surgical patients; this resulted in the exclusion of the mortality prediction model developed by Teres et al. During the development of the APACHE III scoring system, there was recognition that the system might be used in making the PaS decision, although so far, it has not been used for this purpose (Draper, personal communication, January 1992). All of these studies—including others by Zaren and Bergstrom, Schäfer et al., and Sarmiento et al.—that were excluded—developed or tested the prediction models on ICU patient populations, rather than on the larger population of medical admissions.

There have been few studies of PaS criteria for ICUs that have used a disease-specific approach. Brett et al. identified eight clinical attributes believed to predict a complicated clinical course in patients with a diagnosis of drug overdose. If any one of the findings was present, the patient was classified as high risk, otherwise, the patient was classified as low risk. None of the 151 low-risk patients developed complications after admission, yet 70 percent were admitted to the ICU for observation. Callaham and Kassel took the disease-specific approach one step further and made recommendations for tricyclic antidepressant overdose admissions based on a review of fatalities. If no symptoms had developed 6 hours after ingestion, the patient did not require admission to an ICU. Kirk has also made recommendations on drug overdose ICU admission criteria, but these recommendations appear to be based on experience rather than data.

It is distressing to see that after three decades of ICU medicine, so few studies are available to determine which patients can benefit from care received in these locations. The data that are available suggest that there is a group of patients with moderately severe illness, as rated by a diagnosis-specific scale, who will benefit from being in the ICU. This is true even when patients in the CCU are excluded from the analysis. What is required now is that we delineate the predictive values—the upper and lower boundaries for these moderately ill patients—as a function of specific diagnoses to ensure that those patients who can potentially benefit from ICU care will receive it. Those patients who are either too ill or not ill enough can be treated more effectively in other hospital locations.

**Recommendations**

1. Models for determining ICU admission need to be developed and tested.

Much work remains to be done before admission criteria can be developed for ICUs. Of the work that has been completed, postoperative and surgical patients are mixed with medical patients; it is not known whether these models can be applied to the medical group alone. If so, the APACHE system and the mortality prediction model should be studied, with a focus on their usefulness in PaS. If not, new models should be developed for medical patients. Such models need to be developed and validated, then studied in large multicenter, clinical trials.

2. The PaS of patients to alternative patient management locations should be investigated.

The broader picture of PaS should be investigated, whether this evaluation occurs in the field, in the emergency department, on the ward, or in a critical care area.

3. Existing predictive models for early triage decision-making should be summarized.

Data from predictive models that have already been developed and validated should be used.
Recommendations should be made that will eventually lead to standardized guidelines for early transfer.

4. Predictive models that can estimate patient mortality accurately when applied 24 h after admission need to be refined.

We believe that a predictive model based on the available data can be developed. This model will accurately assess mortality risk 24 h after admission and will facilitate the transfer of patients from the ICU to the most cost-effective alternative care site.

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NOTE: A list of the references not included in this article is available from the author.

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